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ABSTRACT

In 1972 there were 33,000 Telex installations in the United Kingdom with 240,000 predicted by 1983. The feasibility of using these Telex systems for on-line accession of computer based information systems was investigated in this report. Comparisons between the Telex system and the Teletypewriter or Teleprinter system now in use reveal that the costs of the Telex system are less than the Teleprinter system. However, the Telex system is one third slower and more errors result. Other features such as computing costs, data retrieved and types of messages are comparable. An examination of technical aspects show that the difficulties are not unsurmountable. Appropriate hardware is available, but existing software would need to be modified. It is recommended that the feasibility of using the Telex system be further investigated in a real experiment. Appendixes contain the character code used by the Telex system, the Teletypewriter system and other systems, a proposed Telex output interchange set, a data bank interchange set, sample enquiries on the Telex and Teletypewriter system with speed comparisons and data on costs. (JG)

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T E L E X

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TELEX

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Short Feasibility Study on using the Post Office Telex Network for On-Line Computer Information Retrieval.

Special Report SR3

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SUMMARY

1. Comparisons of some features in a Telex system with those in a Teleprinter (Teletypewriter) system are as follows:

	TELEX	TELETYPEWRITER
Transmission Rate (characters/sec)	6.7	10
Rental of user terminal (annual)	£295	£424
Rental of Service Equipment at the Computer	£689	£573
Relative line costs of an enquiry	£1	£2
Errors (per 100, 50 character messages)	2.5	-

2. The table above indicates that the costs of the Telex system are less than the Teletypewriter system. However the transmission rate is slower by a third and, as there is no parity checking, there are many more errors.

3. Other features such as computing costs, data retrieved, types of messages, are little different in the two systems.

4. There are currently 33000 Telex installations in the U.K. Forecasts of growth predict 240,000 installations by 1983.

5. There are approximately 10,000 teleprinters at present in the U.K. Forecasts of growth predict that this number should rise to 316,000 by 1983. But there will still be large numbers of people particularly in Business who will have a Telex terminal convenient but no teleprinter and who would therefore wish to interrogate any desired data bank by Telex.

6. There are no insurmountable technical difficulties. The hardware is available. The software would have to be changed to use characters common to both codes as much as possible, and the system would need to know the type of terminal being used to enable it to send out the correct messages each time.

7. We recommend that these conclusions and particularly the cost of making an existing on-line data bank available by Telex as well as teleprinter should be investigated in a real experiment.

1. Introduction

This report describes an investigation aimed at establishing the feasibility of using the Telex system for on-line accession of computer based information systems. It was our purpose to examine briefly the relative merits of using Telex terminals as opposed to the generally accepted use of terminals such as teletypewriters (hereafter simply referred to as teletypewriters). We make the comparison largely by studying the equipment available to us at present at our University, but the conclusions we reach should apply generally to other computer equipment.

In recent years, developments in computer hardware and software have made possible the on-line information storage and retrieval systems which are at present the subject of much detailed investigation. The most significant of these advances have been:

i. the development of random acess devices and associated file storage techniques;

ii. the development of hardware and software enabling many users to time-share computer resources;

iii. the development of communications techniques enabling time-sharing users to operate at locations remote from the computer.

On-line storage and retrieval systems can be broadly classified on the basis of the type of information stored namely: numeric or textual. Examples of numeric data include atomic potentials, engineering design data and mathematical functions. In the textual field, examples are documents, bibliographic references, abstracts and medical records.

The information contained in such data banks should be of great value to a wide range of people working in many different fields. To avail of this information on-line it is necessary to have access to equipment capable of interrogating the data bank. The present means of interrogation is by use of a terminal such as a teletypewriter linked via either a private telegraph circuit or a private/public telephone circuit to the computer.

The terminal typewriter (or visual display unit) is a specialised piece of equipment which is unlikely to be installed except in conjunction with a computer or some other sophisticated equipment such as a data logger or scintillation counter. Consequently, the provision of a link to a computer will represent in numerous cases a substantial capital investment (£1,000 to £2,000). In instances where use of the on-line interrogation facility is of an irregular nature and low volume such investment may be uneconomic.

The Telex system is in widespread use in many of the areas not served by specialised teletypewriter equipment. It offers, therefore, a convenient means whereby irregular users may access data banks without incurring the heavy expense of installing additional equipment.

The remainder of this report examines the various aspects of extending data bank utilisation by employing the Telex service. Frequent comparisons between use of teletypewriters and Telex are included.

2. Telex and Teletypewriter Installations - Some Facts and Figures

At the time this report was written some 33,000 Telex terminals had been installed in the United Kingdom. Of these, some 17,500 were basic models, the remaining 15,500 being fitted with the optional paper tape station. (The Error Detection Unit referred to in Section 9 is not yet freely available so the proportion of installations using it is not significant.)

While it is difficult to assess accurately the distribution of telex installations over the complete field of usage, nevertheless it is possible to get some idea of the pattern of usage by referring to the current Telex directory. The following figures were derived from a random selection of some 250 entries in the directory:

General Classification		Number in sample	Percentage
Manufacturing	(e.g. Manufacturing Industries)	107	43.1
Service Industry	(e.g. Finance & Professional Services)	14	5.7
Commerce	(e.g. Brokers, Agents, Distributive Trades, Representatives, Property)	53	21.4
Basic Commodities	(e.g. Foodstuffs, Clothing, Raw Materials)	33	13.4
Transport	(e.g. Transport and Travel)	19	7.6
Communications Media	(e.g. Printing, Newspapers and Entertainment)	5	2.0
Public Bodies	(e.g. Civil Service, Armed Forces, Universities)	17	6.8
	TOTAL	248	100.0

The use of the service is expanding rapidly with (the installation of 400 new terminals) each month in the United Kingdom, new subscribers coming from all sectors of the industrial, business and public communities. In 10 years time the Post Office predicts that Telex will provide almost total coverage in these sectors, virtually replacing the postal service which will then become almost exclusively confined to residential areas.

Results of a recent market survey indicate that the number of Telex installations in the U.K. will increase 5 - fold in the decade 1973 - 1983. It has been estimated that during the same decade the use of teletypes, or similar slow speed computer terminals, will increase by at least a factor of 12.

The forecasts of growth for both Telex and Teletypewriter installations are summarised in the following table:

Terminal type	1973	1978	1983
Telex	50,000	110,000	240,000
Teletypewriter	27,000	169,000	316,000
Other Fast Data	24,000	65,000	117,000
TOTAL	101,000	344,000	674,000

These forecasts suggest that:

(a) Most on-line computer users will make access to computers using teletypewriters.

(b) Many more will be encouraged to make use of on-line computer access because of developments to link computers with the Telex network.

Telex offers a very high standard of reliability owing to the priority allocated by the Post Office to the maintenance of Telex lines and equipment. In addition, installation delays are not normally as long as those experienced with the switched telephone network. These features of the service are very attractive to the business user and represent a very important advantage if the terminal is likely to be used for data bank interrogation.

3. The Telex System

The Telex system is basically a switched public network of telegraph circuits which work in half-duplex transmission mode, i.e., transmission is possible in either direction, but not simultaneously. The circuits employed are capable of transmitting digital data serially at a speed of 50 bits per second (b.p.s)

The data coding system employed is the 5-bit International Telegraph Alphabet No. 2 (I.T.A. No. 2). Each character of data transmitted requires 5 data bits plus start and stop mark bits - the total data transmitted per character of data is equivalent to 7.5 bits. This means that the maximum data transmission rate is 6.66 characters per second.

Equipment normally supplied by the Post Office as part of a Telex terminal consists of a teleprinter with keyboard and hard copy. A paper tape reader, paper tape punch and error detection unit are also available as options.

A Telex user establishes contact with another Telex user by dialling the appropriate number. Once contact has been established through the telegraph exchange it is possible to switch the receiving end of the line to equipment which permits access to a computer. The switching unit needed can be supplied by the Post Office as an option.

4. Code Conversion

When 5-bit codes are employed, no code conversion is carried out by the line termination units (L.T.U.) or multiplexors (Mx) which are electronic units close to the computer and supplied by the Manufacturer. (We discuss these again later). This means that data must be code converted by the computer on receipt of requests from the interrogating user and also prior to transmission of responses.

A system of code conversion widely employed in computer programs is as follows:

> A table of characters is constructed as part of the program's fixed data and is located in a fixed part of the program's core area. Characters are ordered in this table in such a way that the decimal value of the character to be converted may be used to locate the equivalent internal character. This represents a very rapid and economical conversion procedure. The method may be employed to convert incoming or outgoing data alike.

Code conversion is necessary at two points:-

(a) on input, to convert the 5-bit Telex code into the internal code of the computer being used;

(b) on output, to convert the data bank code in use into the Telex code.

Conversion type (a) presents no serious problems since the internal code of the computer used is normally either 6 or 8 bits per character and fully embraces the Telex Code. (See Appendix I).

Conversion in the reverse direction (i.e. type (b)) does, however, present many problems, since the data bank character set will normally be much wider in scope than the Telex character set. Usually, the data bank will use a 64-character set such as the ISO7 sub-set given in Appendix 2. In some circumstances, a larger set such as the ISO-7 or ASCII data transmission character sets may be used (see Appendix 3).

In any event, the difficulty exists that certain characters in the data bank which are not present in the Telex code must be replaced by Telex characters or by combinations of Telex characters. This aspect of code conversion is fully considered in section 7 below.

5. Hardware Requirements

Remote terminals are connected to a computer via a communication link (telegraph or telephone line) which is terminated in a line termination unit (L.T.U.). The basic function of the L.T.U. is to convert the data from its serial transmission format into a parallel format for use in the computer. The L.T.U. in turn is connected into one channel of a multiplexor which is the scanning device enabling the computer to share its resources between a number of remote terminals.

When data transmission is transmitted by Telex network a 5-bit data transmission code is employed. For transmission over private telegraph lines or public/private telephone lines a 7-bit data transmission code is used. Thus, different L.T.U.'s are needed to terminate the different types of line. For Telex, on an ICL system, an L.T.U. type 7008/1 is required - for a private telegraph or public/private telephone L.T.U. type 7008/2 is needed. In addition, for Telex, a switching unit is required at the computer end to transfer incoming calls to the L.T.U. For telephone lines (public or private) a modem is needed at each end of the line to encode data being transmitted and to decode data being received.

The various ways in which access can be made to an ICL computer via telegraph and telephone lines are demonstrated in Figure 1. Similar access would be needed for other computers.

The L.T.U.'s basic function is to convert data from serial to parallel format. In addition, it must be able to inform the multiplexor when a request to access the computer is initiated at a remote terminal. The L.T.U. does this by recognising specifically chosen characters as being of special significance. In particular, two special characters are required, namely start of message (SOM) and end of message (EOM), each item of data transmitted being bracketed by these two characters.

With ICL hardware the 'figure shift' (fs) is usually employed for SOM and 'figure shift plus' (fs+) for EOM when using the 5-bit transmission code, I.T.A. No. 2, as used by Telex. For 7-bit transmission code, ISO-7, ICL uses 'CNTRL A" as SOM and 'ACCEPT' as EOM.

Various error conditions are also monitored by the L.T.U.

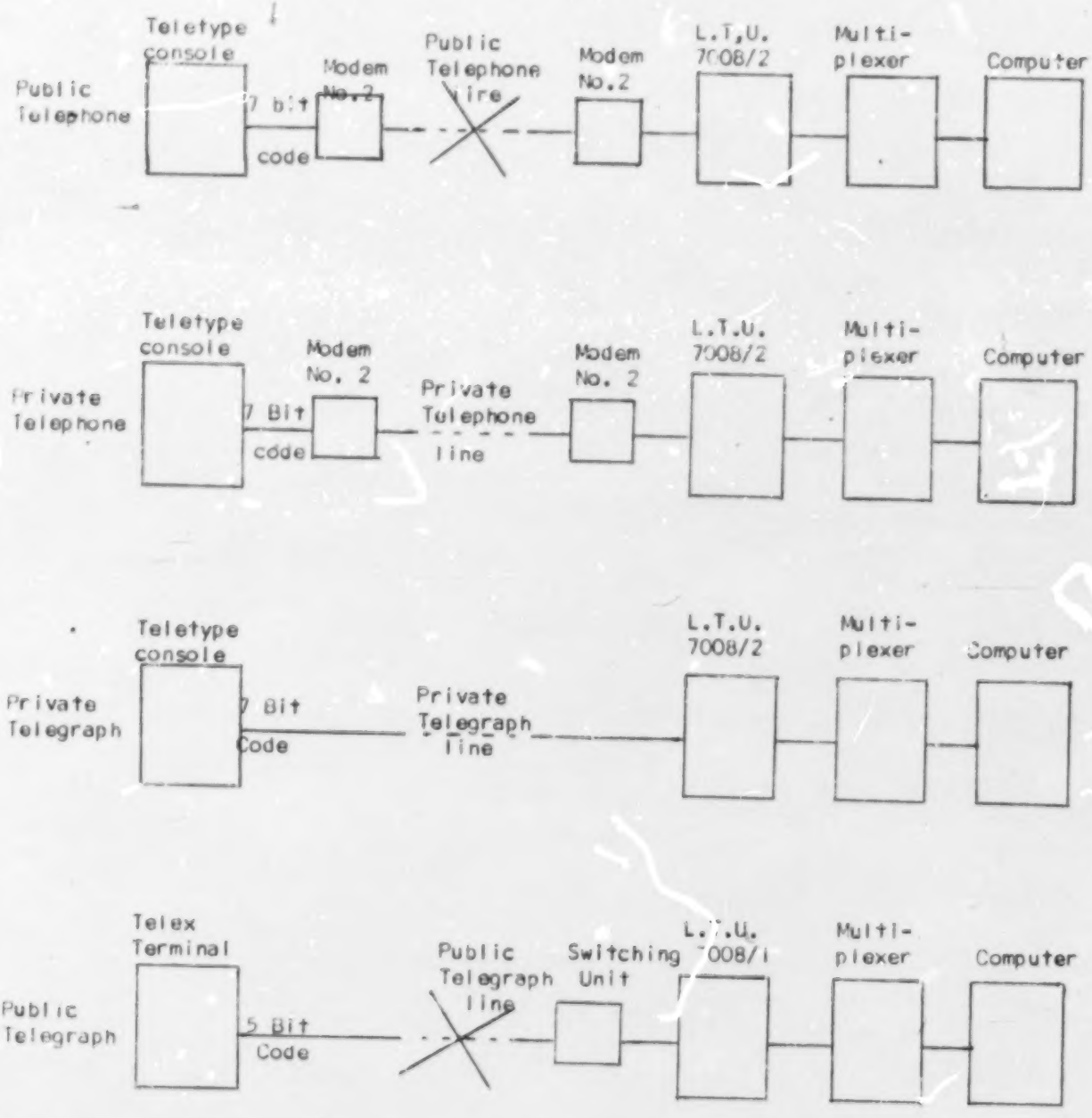
When the multiplexor receives data in the 7-bit transmission code it converts each character into the 3-shift 6-bit internal code of the computer. In contrast data transmitted in the 5-bit code does not undergo conversion by the multiplexor hardware.

The multiplexor passes the data into the program associated with the terminal via the multiplexor control package and the machine supervisory software.

c. Communications Software

Communications terminals are not entirely under the control of the software package controlling the multiplexor. The terminal effectively activates (or 'wakes up') the package whenever the user presses the start of message key. The message is then typed and terminated by pressing the end of message key. The control package, which at Queen's is called MCS

FIGURE 1 Methods of access to an ICL 1900 Computer via Telephone and Telegraph lines.



(Multiplexor Control System), checks the message and passes it to the application program associated with the particular terminal. The association between a particular terminal and a particular application program must be set up by special messages, called commands, passed from the terminal to the control package. These commands are usually recognised by a special character immediately following the SOM character. MCS recognises its commands by the '£' character. In the MCS system there are about 12 commands which carry out the following tasks:

(a) control access to application packages and disc data banks by a password system;

(b) allow some control by the user over output to the terminal by specifying line limits;

(c) enable information programs which were developed using a card reader and line printer as input and output devices, to be made available to terminal users without any alteration.

Systems such as MCS must take special action when error conditions develop on the transmission line, such as: line inoperable (short circuit), lost input or no input when expected (Timed Out). In the case of a Telex enquiry an additional special action would be necessary, namely recognising the Telex line and converting the 5-bit data transmission code to 3 shift 6-bit internal computer code (see Appendix 4) and passing the associated message, with an indication that it originated at a Telex terminal, to the appropriate application program.

It is logical to carry out this conversion in the first piece of alterable software after the message has come from the multiplexor since, in the case of a 7-bit data transmission code, the conversion is carried out by hardware in the multiplexor.

7. Consideration of Telex Character Set in Relation to Applications Programs

The application program allows the information system to be turned to a particular application. Many varied applications can be catered for by having a library of application programs available in the system. The time-sharing capability of the operating system should enable many applications to be dealt with at the same time with one or more users of each application.

Messages passed from the terminal via the operating system to the application program are analysed and interpreted according to the conventions adopted by the original designer of the application program. In deciding these conventions he would have been restricted by the 64 printing character set of the teletypewriter to be used for normal enquiries. In general, an enquiry from a terminal would involve the retrieval of information for a disc-based data bank by the application program. Consequently, when setting up the data banks, it is convenient to restrict the character set to the 64 characters of a teletypewriter.

Information to be stored in a data bank normally makes use of a more extensive character set than is available on the teletypewriter keyboard. Thus, it is often necessary to replace certain characters in the data being stored, by combinations of the characters available in the teletypewriter character set.

An example of this technique is as follows:

Information being stored	Data bank representation
∝	Alpha
&	AND
a to z	A to Z
A to Z	A to Z

Publishing conventions(such as the use of italic script in documents) are usually removed from the text.

The short example above indicates how certain characters are replaced by character combinations (e.g. AND for &), how others are replaced by alternative equivalent characters ('lower case' becomes 'upper case') and how others are unchanged (A remains as A).

This character set used by the data bank is normally referred to as the 'interchange character set' with which the terminal user must become familiar. An example of an interchange character set is given in Appendix 6.

When using a Telex terminal to interrogate a data bank the character set available to the user is even more restricted than that used in setting up the data bank. This situation arises because the telex teleprinter was designed to operate on a 2 shift 5-bit data transmission code thus restricting its printing character set to 51 characters. The data bank, which makes use of the computer internal 3 shift 6-bit or 8-bit machine code, was set up within the 64 printing character set of the teletypewriter. Although the teletypewriter uses single shift 7-bit data transmission code allowing 128 characters, its keyboard only permits 64 printing characters because the lower case characters and some special symbols are not permitted (see Appendix 2). The latest, more expensive teletypewriters have extended their printing range to the full set of 95 printing characters of the ISO-7 code and if new data banks are set up with these terminals in mind, the gulf between the Telex character set and the new teletypewriter character set may be too wide to be bridged by an interchange character set. Obviously the choice of these more expensive teletypewriters would have to be justified by the cost effectiveness of a particular application and the Telex user may be barred from particular sophisticated applications.

The on-line interrogator inputs data by issuing directives of two types:

(a) commands to the Multiplexor Control System (MCS) which are interpreted and acted upon by MCS;

(b) enquiries to the application program which initiate a retrieval of information from the data bank and are interpreted by the application program.

Type (a) directives have already been dealt with in Section 5 above, although it is important to note that all of the MCS commands can be adequately represented without character interchange in the Telex character set. For other multiplexor control systems it may be necessary to employ a Telex interchange character set.

Type (b) directives are formulated when the particular application program is written. If at that time the writer is aware of the likelihood of the program being driven from a Telex terminal then he should try to ensure that all program directives employ the Telex character set without use of interchange characters. In certain cases this rule may be too restrictive and it will be necessary for special character combinations to be employed.

However, information being output from the data bank to a Telex terminal will virtually always require the use of an interchange character set. An example of an interchange set linking the ICL 64-character teletypewriter set to the Telex character set is shown in Appendix 5.

6. Speed

The number of characters per second transmitted between a computer and a terminal depends upon both:

(a) the speed of the transmission line in bits per second;

(b) the number of bits used in the character code to represent a character.

A teletypewriter uses the 7 data bit plus parity code, and with synchronising bits requires 11 bits to represent one character.

A private telegraph line operates at a speed of 100 bits/second, whereas a telephone line operates at 110 bits/second. Hence, a teletypewriter can

receive or transmit characters at

(a) 9 chrs/sec. on a private telegraph line

(b) 10 chrs/sec. on a public or private telephone line.

A telex terminal uses a 5 bit code and requires 7.5 bits to represent one character.

The public telegraph (Telex) network operates at a speed of 50 bits/sec. and hence, a Telex terminal can receive or transmit characters at 50/7.5 = 6.66 characters/second.

Assuming most teletypewriters are connected to the computer via the public telephone network, then by including the Telex network, terminals used for information processing would operate at speeds of either:

(a) 10 characters per second for teletypewriters

(b) 6.7 characters per second for Telex terminals.

This difference in speed would not present any technical problems in transmission, as each message passed between a terminal and the computer is bounded by SOM and EOM characters, which control the computer's operation with respect to a particular terminal.

Moreover, a given computer could service many more of the slower Telex terminals than the faster teletypewriter terminals.

An enquiry of 100 messages of 60 characters each, lasting 14 minutes using a teletypewriter, would take 20 minutes on a Telex terminal. (see Appendix 7 for details). This should not tie up the data bank or use any more computer power in a time sharing environment, and consequently a Telex user should not be charged any more for the longer enquiry.

9. Error Detection

There is no standard system of error control on telegraph circuits, although several proposals for error checking have been made. On private

telegraph circuits and public or private telephone circuits the Line Termination Unit (L.T.U.) at the computer end of the communication line detects a parity bit inserted by the teletypewriter. (see Section 5). To achieve this the data transmission code used by the teletypewriter is in fact 7-data bits plus 1 parity bit. Although this is the standard method of error detection when using a teletypewriter, additional checks can be made by using reflected data transmission or by having a more expensive teletypewriter with a "built-in" parity check facility.

Reflected data transmission is controlled by the line termination unit. This may be specified to reflect each character received from the line back to the teletypewriter which originated it, as well as passing the character on to the multiplexor. The character printed on the teletypewriter platen will then be the one actually received by the L.T.U.: if it is different from that keyed, this fact will be apparent on the printed copy. In practice the operator is unaware of the difference between a character being printed directly it is keyed and its being printed on reflection from the L.T.U.: the rate of typing is therefore unaffected by the reflected data facility.

On the public telegraph circuits (TELEX), the Telex terminals do not generate parity bits and operate on a strictly 5-bit transmission code. Consequently no parity checks, as described above for teletypewriters, can be made by the line termination units for Telex terminals. Neither is it possible to use reflected data transmission.

However, the Post Office has developed an error detection unit (E.D.U.) employing the 'backward signal' or 'information feed-back' method for use on Telex and telegraph private circuits operating at speeds up to 50 bits per second. This E.D.U. is not normally supplied with a telex terminal but can be obtained from the P.O. for additonal charge.

Since very few Telex terminals have this Error Detection Unit, and no other form of error detection is possible; it is instructive to note that according to the P.O. the average error rate on Telegraph circuits is between 1 in 2×10^3 and 4×10^3 characters. Errors are not distributed uniformly, but tend to occur in bursts, and the proportion of error free messages is much higher than the average number of errors suggests. The E.D.U. will reduce undetected errors to something better than 1 in 10^6 characters.

With no form of hardware error detection, the task of detecting unintelligent messages would be left to the terminal operator on output and to the software on input. Remedial action can easily be taken by the operator on receipt of a corrupted output message, but a corrupted input message may be undetected by the software and result in incorrect information being given during an enquiry. In particular a corrupted character may be interpreted as S.O.M. (Start of Message) or E.O.M. (End of Message), both of which are control characters and generate special actions. An E.O.M. character in the middle of an incoming message can result in a loss of the line.

From the figures on the rate of error above, if we assume the worst possible case of 1 in 2000 characters and only one corrupted character per message, then for an average message length of 10 characters 1 in 200 messages will be corrupted. The rate of error for input messages which are more serious would be approximately 1 in 400.

10. Paper Tape

A paper tape unit comprising a punch and a reader can be attached to teletypewriters. A similar unit is available for a Telex terminal. This unit can be used to punch messages on paper tape while the terminal is not connected to the computer, and later used to read the paper tape and transmit the messages to the computer. The aim of this procedure is to minimise transmission of

incorrect messages and reduce the connect time of a terminal using the system. The normal paper tape unit supplied with the teletype causes technical problems resulting in a loss of the line. Such problems occur when responses to messages are expected, as would be the case during an enquiry using an information retrieval system. A special paper tape unit which prevents these problems is available for a teletype but the limited character code of the Telex system would not permit the design of a similar special paper tape unit for a Telex terminal. Consequently, we would not recommend the normal paper tape units to be used for information retrieval either on a teletypewriter or a Telex terminal. However, they are useful for normal P.O. Telex to Telex communication and for this reason comparison of costs in Section II include paper tape units.

II. Comparison of Costs

For the purpose of comparison of costs it is assumed that the remote user will use either a teletype console connected to the computer through the public telephone network or a Telex terminal connected through the Telex network. (See Appendix 8 for schemata). Installation and running costs of both the remote station and central computer installation are compared.

(a) Remote Installation Costs

The Telex line does not require a modem, whereas the telephone line does. A comparison of annual rental between these two systems is as follows:

	ANNUAL RENTAL	
	Telex System	Teletype System
Terminal	£295	£324
Modem	NIL	£100

In addition, a connection charge of £10 is required for a Telex Terminal. (See Appendix 9).

(b) Call Charges

Charges for Telex calls are approximately equal to charges for Telephone calls at the P.O. cheap rate, i.e., 1/3 of full rate (see Appendices 9 and 11). Against this it must be remembered that the Telex terminal operates at approx. 67% of the speed of the teletype and the line would be connected 1½ times as long as the teletype line. Consequently, assuming the worst case where terminals are active 100% of the connect time and the teletype console enquiry = 1, then Telex console enquiry cost = 1/3 x 3/2 x 1 = 0.5.

This agrees with the Post Office claim that Telex calls are 50% cheaper than telephone calls.

(c) Installation Costs of Service Equipment at the Central Computer

To service a number of enquiries simultaneously, the central computer installation requires line termination equipment for as many lines as may be required by remote users at the same time. Each teletype console using a telephone line must be connected through a Modem and line termination unit (L.T.U.) to the computer. At present a Telex Terminal using a telegraph line requires a matching Telex terminal at the computer end as well as a switching unit and telegraph L.T.U. The second Telex Terminal is used to establish the link from the remote terminal to the computer installation, but during an enquiry it is not used as the line is switched through the switching unit to the computer. The P.O. have recently announced Data Control Equipment (DCE3) which enables incoming calls to a Telex Terminal to be answered automatically and switched to the

computer. This is a less expensive and more attractive alternative to terminals and switching units for each incoming line. (See Appendix 12).

A comparison of annual rental charges between the two sets of service equipment is as follows:

	ANNUAL RENTAL	
	Telex System	Teletype System
L.T.U.	£384	£468
Modem	NIL	£105
Telex Terminal	£295*	
Switching Unit	10	
TOTAL	£689	£573
Connection Charges	10	

* May be less if Telex Data Control Equipment DCE3 is installed. (See Appendix 10).

(d) Running Costs of Central Computer

The running costs of the central computer installation should be the same for both systems. Consequently the charge for the use of the computer and maintenance of the data bank should be the same for either a Telex user or a Teletype user.

(e) Cost of Software Changes required to Offer a Telex Service

These would include:

(i) software changes in Multiplexor package;

(ii) software changes in application packages (including amended ON-LINE instructions to a Telex user);

(iii) no changes to a data bank.

APPENDIX 1

Telex Code — I.T.A. No. 2 Alphabet

Letters Case	Figures Case	CODE
A	-	11 o 000
B	?	10 o 011
C	:	01 o 110
D	WRU	10 o 010
E	3	10 o 000
F	% } National	10 o 110
G	@ } Characters	01 o 011
H	£ }	00 o 101
I	8	01 o 100
J	Bell	11 o 010
K	(	11 o 110
L	)	01 o 001
M	.	00 o 111
N	,	00 o 110
O	9	00 o 011
P	0	01 o 101
Q	1	11 o 101
R	4	01 o 010
S	' (apostrophe)	10 o 100
T	5	00 o 001
U	7	11 o 100
V	=	01 o 111
W	2	11 o 001
X	/	10 o 111
Y	6	10 o 101
Z	+	10 o 001
Carriage return		00 o 010
Line feed		01 o 000
Letters		11 o 111
Figures		11 o 011
Space		00 o 100

In the following table, 1 represents a mark signal (a hole in punched tape) and 0 a space signal (no hole).

International telegraph alphabet No. 2

The above is the 51 print character code used by the Telex system.

APPENDIX 2

Teletypewriter 64 - character ISO - 7 sub-set

	000	001	010	011	100	101	110	111
0000	TC_0(NULL)	TC_7(DLE)	Space	0	@	P		
0001	TC_1(SOH)	DC_1(DC)	!	1	A	Q		
0010	TC_2(STX)	DC_2	"	2	B	R		
0011	TC_3(ETX)	DC_3	#	3	C	S		
0100	TC_4(EOT)	DC_4(STOP)	£	4	D	T		
0101	TC_5(ENQ)	TC_8(NAK)	%	5	E	U		
0110	TC_6(ACK)	TC_9(SYN)	&	6	F	V		
0111	BEL	TC_{10}(ETB)	'	7	G	W		
1000	FE_0(BS)	CNL	(	8	H	X		
1001	FE_1(HT)	EM	)	9	I	Y		
1010	FE_2(NL)	SS	*	:	J	Z		
1011	FE_3(LF)	ESC	+	;	K	[		
1100	FE_4(FF)	IS_4(FS)	,	<	L	\		
1101	FE_5(CR)	IS_3(GS)	-	=	M	]		
1110	SO	IS_2(RS)	.	>	N	↑		
1111	SI	IS_1(US)	/	?	O	←		/// (delete)

Interrogating typewriter facility code used by the teletypewriter console.

This is a sub-set of ISO-7 (ASCII and I.T.A. No. 5)

It has 64 printing characters.

The new P.O. Data Service to be in operation in 1977 hopes to use the full I.S.O.-7 code. Consequently the new Teletypewriter consoles are designed to operate on the full set i.e., including upper and lower case letters.

APPENDIX 3

Full ISO-7 data transmission set

							0	0	0	0	1	1	1	1
							0	0	1	1	0	0	1	1
							0	1	0	1	0	1	0	1
b_6	b_5	b_4	b_3	b_2	b_1	b_0	Zone / Numeric	0	1	2	3	4	5	6	7
			0	0	0	0	0	TC_0 (NULL)	TC_7 Data Link Escape	space	0	@ (at)	P	_ (underline)	p
			0	0	0	1	1	TC_1 Start of Heading	DC_1 Device Control	! (exclamation)	1	A	Q	a	q
			0	0	1	0	2	TC_2 Start of Text	DC_2	" (quotes)	2	B	R	b	r
			0	0	1	1	3	TC_3 End of Text	DC_3	# (number)	3	C	S	c	s
			0	1	0	0	4	TC_4 End of Transmission	DC_4 (STOP)	£ (pound	4	D	T	d	t
			0	1	0	1	5	TC_5 Enquiry	TC_8 Negative Acknowledge	% (per cent)	5	E	U	e	u
			0	1	1	0	6	TC_6 Acknowledge	TC_9 Synchronous Idle	& (ampersand)	6	F	V	f	v
			0	1	1	1	7	BEL Bell, alarm	TC_{10} End of Transmission Block	' (apostrophe)	7	G	W	g	w
			1	0	0	0	8	FE_0 Backspace	CNCL Cancel	((l. parenth.)	8	H	X	h	x
			1	0	0	1	9	FE_1 Horizontal Tabulation	EM End of Medium	) (r. parenth.)	9	I	Y	i	y
			1	0	1	0	10	FE_2 New Line (Line Feed)	SS Start of Special Sequence	* (asterisk)	: (colon)	J	Z	j	z
			1	0	1	1	11	FE_3 Vertical Tabulation	ESC Escape	+ (plus)	; (semi colon)	K	[(l.h. brkt)	k	N1
			1	1	0	0	12	FE_4 Form Feed	IS_4 File Separator	, (comma)	< (less than)	L	\ (dollar)	l	N2
			1	1	0	1	13	FE_5 Carriage Return	IS_3 Group Separator	- (hyphen/minus)	= (equals)	M	] (r.h.brkt.)	m	N3
			1	1	1	0	14	SO Shift Out	IS_2 Record Separator	. (period)	> (greater than)	N	↑	n	N4
			1	1	1	1	15	SI Shift IN	IS_1 Unit Separator	/ (solidus)	? (question)	O	←	o	(delete)

Reserved for National Characters

The 1900 Series data transmission code

This is the ISO-7 and ASCII and International Telegraph Alphabet No. 5 code with a few variants.

APPENDIX 4

Internal 3 shift 6-bit code of the ICL 1900 computer

	3 most significant bits							
	000	001	010	011	100	101	110	111
0000	TC_0 NULL δ*20	TC_7 DLE δ*00	Space $\alpha\beta$*20	0 $\alpha\beta$*00	@ α*40	P α*60	— β*40	p β*60
0001	TC_1 SOH δ*21	DC_1 DC δ*01	! $\alpha\beta$*21	1 $\alpha\beta$*01	A α*41	Q α*61	a β*41	q β*61
0010	TC_2 STX δ*22	DC_2 δ*02	" $\alpha\beta$*22	2 $\alpha\beta$*02	B α*42	R α*62	b β*42	r β*62
0011	TC_3 ETX δ*23	DC_3 δ*03	# $\alpha\beta$*23	3 $\alpha\beta$*03	C α*43	S α*63	c β*43	s β*63
0100	TC_4 EOT δ*24	DC_4 Stop δ*04	£ $\alpha\beta$*24	4 $\alpha\beta$*04	D α*44	T α*64	d β*44	t β*64
0101	TC_5 ENQ δ*25	TC_8 NAK δ*05	% $\alpha\beta$*25	5 $\alpha\beta$*05	E α*45	U α*65	e β*45	u β*65
0110	TC_6 ACK δ*26	TC_9 SYN δ*06	& $\alpha\beta$*26	6 $\alpha\beta$*06	F α*46	V α*66	f β*46	v β*66
0111	BEL δ*27	TC_{10} ETB δ*07	' $\alpha\beta$*27	7 $\alpha\beta$*07	G α*47	W α*67	g β*47	w β*67
1000	FE_0 BS δ*30	CNL δ*10	($\alpha\beta$*30	8 $\alpha\beta$*10	H α*50	X α*70	h β*50	x β*70
1001	FE_1 HT δ*31	EM δ*11	) $\alpha\beta$*31	9 $\alpha\beta$*11	I α*51	Y α*71	i β*51	y β*71
1010	FE_2 NL/LF δ*32	SS δ*12	* $\alpha\beta$*32	: $\alpha\beta$*12	J α*52	Z α*72	j β*52	z β*72
1011	FE_3 VT δ*33	ESC δ*13	+ $\alpha\beta$*33	; $\alpha\beta$*13	K α*53	[α*73	k β*53	N1 β*73
1100	FE_4 FF δ*34	IS_4 FS δ*14	, $\alpha\beta$*34	< $\alpha\beta$*14	L α*54	$ δ*64	l β*54	N2 δ*70
1101	FE_5 CR δ*35	IS_3 GS δ*15	- $\alpha\beta$*35	= $\alpha\beta$*15	M α*55	] δ*65	m β*55	N3 δ*71
1110	SO δ*36	IS_2 RS δ*16	. $\alpha\beta$*36	> $\alpha\beta$*16	N α*56	↑ δ*66	n β*56	N4 δ*72
1111	SI δ*37	IS_1 US δ*17	/ $\alpha\beta$*37	? $\alpha\beta$*17	O α*57	← δ*67	o β*57	\\\ δ*73

ACK	Acknowledge	GS	Group Separator
BEL	Bell, alarm (to sound)	HT	Horizontal Tabulation
BS	Backspace	IS	Information Separator
CNL	Cancel	LF	Line Feed (to start new line)
CR	Carriage Return	NAK	Negative Acknowledge
DC	Device Control	RS	Record Separator
DLE	Data Link Escape	SI	Shift In
EM	End of Medium	SO	Shift Out
ENQ	Enquiry (ENQ)	SOH	Start of Heading (SOH)
EOT	End of Transmission (EOT)	SS	Start of Special Sequence
ESC	Escape	STX	Start of Text
ETB	End of Transmission Block (ETB)	SYN	Synchronous Idle
ETX	End of Text	TC	Transmission Control
FE	Format Effector	US	Unit Separator
FF	Form Feed	VT	Vertical Tabulation
FS	File Separator	*	Indicates the octal equivalent of a binary number.

Internal 3 shift 6-bit equivalents of the 1900 Series data transmission code

This is the code used in the ICL central processor during execution of Information Retrieval Programs.

APPENDIX 5

TELEX OUTPUT INTERCHANGE SET

The INSPEC interchange set (see Appendix 6) is a sub-set (55 characters) of the full character set (approx. 700 symbols) used in most mathematical and other forms of text to be stored for later retrieval. This sub-set can be represented both in Mix-bit BCD and in eight-bit EBCDIC codes and is necessary if information is to be stored and retrieved on computer equipment.

The Telex terminal operates on five-bit code and thus the INSPEC interchange set needs to be condensed further from 55 to 48 printing characters.

The following is an attempt at setting up a "Telex Output Interchange Set" which condenses the six-bit Inspec Interchange set into the five-bit Telex set.

INSPEC Normal Interchange character	TELEX Interchange Character
0 to 9	0 to 9
A to Z	A to Z
SPACE	SPACE
,	,
;	,
:	:
?	?
!	:
'	'
.	.
(	(
)	)
⊏	(
⊐	)
<	LT
>	GT
=	=
+	+
-	-
*	%
/	/

APPENDIX 6

DATA BANK INTERCHANGE SET

6. CHARACTER SET

6.1 The INSPEC character set contains some 700 separate symbols, if variations in typographic style and alignment are taken into consideration. For public tapes, the full character set will be condensed into a limited set - the "INSPEC interchange set" - which can be represented both in six-bit BCD and in eight-bit EBCDIC codes. To achieve this, typographic shifts will be removed completely from the data fields, certain common characters will be translated into other symbols to which they are closely related, and many rarely-used mathematical symbols will be replaced by a 'delete' code, each occurrence of which indicates that a special symbol has been removed. A few common symbols not available in BCD will be translated into words, e.g. PERCENT, ALPHA.

6.2 The following table lists all characters that can appear on INSPEC internal files and gives the character (or character string) in the INSPEC interchange code that is used to represent each of these internal characters on magnetic tapes derived from the INSPEC data base

INSPEC internal character	Corresponding interchange character(s)	INSPEC internal character	Corresponding interchange character(s)
0 to 9	0 to 9	×	*
:	:	÷	/
;	;	<	<
subscript shift	/SUB .../	>	>
=	=	∤	/
superscript shift	/SUP .../	∗	/
space	♭	≤	/
(	(	≥	/
)	)	≲	<
bold shift	removed from text	≳	>
italic shift	removed from text	≒	=
,	,	≪	<
- (hyphen)	-	≫	>
.	.	≠	NOT EQUAL TO
/	/	− (minus)	-
thin space	removed from text	≡	=
a to z	A to Z	≒	=
A to Z	A to Z	α	ALPHA
[	[	β	BETA
]	]	γ	GAMMA
+	+	δ or ∂	DELTA
±	+OR-	ε or ∈	EPSILON
∓	-OR+	ζ	ETA

6.2 continued

INSPEC internal character	Corresponding interchange char.	INSPEC internal characters	Corresponding interchange char.
η	ZETA	$\subseteq$	/
Θ or ϑ	THETA	$\supseteq$	/
ι	IOTA	ϕ	/
κ	KAPPA	φ	/
λ	LAMDA	$\wedge$	/
μ	MU	$\cup$	/
ν	NU	$\cdot$	/
ξ	XI	$\in$	/
o	OMICRON	$\not\in$	/
π	PI	$\mid$	/
ρ	RHO	$\parallel$	/
σ	SIGMA	$\aleph$ (aleph)	/
τ	TAU	$\mathfrak{A}$ to $\mathfrak{Z}$ (Gothic)	A to Z
υ	UPSILON	$\mathcal{A}$ to $\mathcal{Z}$ (Script)	A to Z
φ	PHI	$\rangle$	)
χ	CHI	$\langle$	(
ψ	PSI	$\rightarrow$	=
ω	OMEGA	$\leftarrow$	=
(	(	$\rightleftarrows$	=
)	)	$\leftrightarrows$	=
~	=	$\rightleftharpoons$	=
$\approx$	=	$\#$	=
$\simeq$	=	$\surd$	SQROOT
$\cong$	=	$\sqrt[n]{}$	NTHROOT
$\subset$	/	$\int$	INTEGRAL
$\supset$	/	$\oint$	C.INTEGRAL
$\cap$	/	$\iint$	D.C.INTEGRAL
$\cup$	/	∞	INFINITY

6.2 continued

INSPEC internal characters	Corresponding interchange chars.	INSPEC internal characters	Corresponding interchange chars.
∝	=	-	\
°	DEGREES	EN	–
′ (min)	MINUTES	/ (tracbar)	/
″ (sec)	SECONDS	%	PERCENT
⊕	/	å ~ Å	AA
⊖	/	¢	C
⊗	/	ħ	HCROSS
⊙	/	ŧ or Ŧ	LCROSS
□	/	ñ	N
⊥	/	ø or Ø	OE
∠	/	z ~ Z	Z
‹	-		
›	-		
¡	!		
¿	?		
&	AND		
*	*		
£	/		
$	/		
†	/		
‡	/		
¯	/		
ˋ	/		
ˆ	/		
ˇ	/		
˘	/		
˜	/		
¨	/		

NOTES.

1. Subscript or superscript strings are translated using the /SUB ../ or /SUP ../ conventions respectively.

   Hence the expression:-

   e^{x+1} becomes 'e/SUP X+1/

2. The code indicating that an INSPEC internal character has no corresponding interchange code is '\'.

3. Upper case Greek characters are represented by the same alphabetic strings as given for lower case.

6.3

The following table gives the bit patterns on 7 and 9 track tape, representing each character in the INSPEC interchange set.

NOTE: 9 track codes are those produced by the standard IBM copy program with the translate feature 'on'.

Interchange character	7-track BCD	9-track EBCDIC
0	001010	1111 0000
1	000001	1111 0001
2	000010	1111 0010
3	000011	1111 0011
4	000100	1111 0100
5	000101	1111 0101
6	000110	1111 0110
7	000111	1111 0111
8	001000	1111 1000
9	001001	1111 1001
A	110001	1100 0001
B	110010	1100 0010
C	110011	1100 0011
D	110100	1100 0100
E	110101	1100 0101
F	110110	1100 0110
G	110111	1100 0111
H	111000	1100 1000
I	111001	1100 1001
J	100001	1101 0001
K	100010	1101 0010
L	100011	1101 0011
M	100100	1101 0100
N	100101	1101 0101
O	100110	1101 0110
P	100111	1101 0111
Q	101000	1101 1000
R	101001	1101 1001
S	010010	1110 0010
T	010011	1110 0011
U	010100	1110 0100
V	010101	1110 0101
W	010110	1110 0110
X	010111	1110 0111
Y	011000	1110 1000
Z	011001	1110 1001
␣ (space)	010000	0111 1010
,	011011	0110 1011
;	101110	0101 1110
:	001101	0111 1101
?	111010	1100 0000
!	101010	1101 0000
'	001011	0111 1100
.	111011	0100 1011
(	011100	0110 1100
)	111100	0100 1100

6.3 continued

Interchange character	7-track BCD	9-track EBCDIC
[	111101	0100 1101
]	101101	0101 1101
≤	111110	0100 1110
>	001110	0111 1110
=	001011	0111 1011
+	110000	0101 0000
-	100000	0110 0000
*	101100	0101 1100
/	010001	0110 0001
\ deleted char.	011110	0110 1110
∮ delimiter	101011	0101 1011
≠ field terminator	011010	1110 0000
≢ record terminator	111111	0100 1111
✓ tape mark	001111	0111 1111

6.4 ICL 6-bit code representation of INSPEC Interchange character set.

Interchange character	ICL 6-bit code (in core)
0	#00
1	01
2	02
3	03
4	04
5	05
6	06
7	07
8	10
9	11
A	41
B	42
C	43
D	44
E	45
F	46
G	47
H	50
I	51
J	52
K	53
L	54
M	55
N	56
O	57
P	60
Q	61
R	62
S	63
T	64
U	65
V	66
W	67
X	70
Y	71
Z	72
space	20
,	33
;	13
:	12
?	17
!	21
'	27

Interchange character	ICL 6-bit code (in core)
.	#36
(	30
)	31
¢	73
∨	75
∧	14
=	16
+	15
-	33
*	35
/	32
deleted character	37
delimiter	23
field terminator	34
record terminator	76
tape mark	77
	63

APPENDIX - 7

Comparison of Speeds

Analysis of input and output messages for two enquiries using a teletypewriter to packages run under the MCS system at Queen's University Belfast. Character counts include non-printing characters inserted by MCS to control the terminal and set the format of the log.

ENQUIRY 1 to an Inter-atomic Potentials retrieval package.

Messages output to the terminal	= 101 Average number of characters = 60
Messages input from the terminal	= 36 Average number of characters = 4
Total time taken	= 14 Minutes
Ratio of Output messages to Input message	= 3
Number of characters output (including non printing characters)	= 6060
Number of characters input " " "	= 144
Total number of characters transmitted " "	= 6204
Teletypewriter transmission speed	= 10/characters/second
Telex transmission speed	= 6.7 characters/second
Ratio of Telex/Teletypewriter speeds	= 67%
Active time for teletypewriter	= 10 minutes
Active time for Telex	= 16 minutes
Ratio of active time to connect time on a teletypewriter	= 10/14 = 5/7

ENQUIRY 2 to a Book Retrieval Package

Messages output to the terminal	= 109 Average no. of chars. = 70
Messages input from the terminal	= 31 Average no. of chars. = 4
Total time taken	= 14 minutes
Ratio of output messages to input messages	= 3.5
Number of characters output (including non-printing characters)	= 7630

Number of characters input (including non-printing characters)	=	124
Total number of characters transmitted " " "	=	7754
Teletypewriter transmission speed " " "	=	13 characters/second
Telex transmission speed	=	6.7 characters/second
Ratio of Telex/Teletypewriter speeds	=	67%
Active time for Teletypewriter	=	13 minutes
Active time for Telex	=	19 minutes
Ratio of active time to connect time for the teletypewriter	=	13/14

From the above two examples it can be seen that the ratio active time to connect time bears no relation to one another, as it depends on the typing, speed of the user, the packages being used and the nature of the information being retrieved. The inter-atomic potential messages tend to be short but contained a lot of information, whereas the book retrieval messages are long and easily understood. The ratio of output messages to input messages was between 3 and 4. The calculated extra time for Telex of at most 6 minutes on a 14 minute enquiry does not seem unreasonable.

ENQUIRY 1 to an Inter-atomic Potentials retrieval package

```
MCS : BATH  < VERSION 9        FEB 75
    : $JOB,BUNK,ABBF0112
MCS : PASSWORD?
    : [redacted]
MCS : LINE   14        LOGIN / BUNK     ABBF0112
      TIME: 14/54/57
      DATE: 22/10/71
    : $RUN,CHAT
MCS : CHAT(CORE:12928)

CHAT: INTERATOMIC POTENTIALS
CHAT: FAMILIAR WITH SYSTEM?-"YES"OR"NO"?
    : YES
CHAT: ATOM PAIR?
    : LI LI
CHAT: YOU MUST HAVE MADE A TYPING ERROR.TYPE THAT ANSWER AGAIN
    : H H
CHAT: YOU MUST HAVE MADE A TYPING ERROR.TYPE THAT ANSWER AGAIN
    : LI LI X
CHAT: ENERGY AND LENGTH UNITS ?
    : ?
CHAT: ENERGY UNITS :-
CHAT: AU    : ATOMIC UNITS
CHAT: CM-1  : CM-1 (ENERGY)
CHAT: EV    : ELECTRON VOLTS
CHAT: ERG   : ERGS
CHAT: RYDB  : RYDBERG
CHAT: LENGTH UNITS :-
CHAT: AU    : ATOMIC UNITS
CHAT: CM    : CENTIMETRES
CHAT: A     : ANGSTROMS
CHAT: TYPE ENERGY & LENGTH UNITS ON LINE,SPACE BETWEEN
MCS : BREAK:  8107  ON LINE LIMIT
    : $RESUME
    : AU AU
CHAT: ALL,BEST, OR RNGE ?
    : ?
CHAT: THE OPTIONS ARE :
CHAT: ALL : THIS ALLOWS A CHOICE OF ALL POTENTIALS STORED
CHAT: BEST : OUR ESTIMATE OF THE POTENTIAL BEST FITTING THE
CHAT: AVAILABLE DATA
CHAT: RNGE : BEST POTENTIAL AVAILABLE IN A RANGE OF R TO BE SELECTED
    : ALL
CHAT: POTENTIALS STORED FOR   LI2   X 1  SIGMA + (G)
CHAT: NO    TYPE                  RANGE(AU  )
CHAT:  1  VAN DER WAAL'S COEFF  0.979E 01 TO 0.990E 02 (LONG RANGE  )
CHAT:  2  RKR                   0.379E 01 TO 0.752E 01 (INTERMEDIATE)
CHAT:  3  BORN-MAYER            0.100E 01 TO 0.300E 01 (SHORT)
```

```
CHAT: 99  OTHER FITS
CHAT: WHICH?
    : 1
CHAT: SHORT    SCRIPTION ?
    : ?
CHAT: IF YOU ANSWER "YES" YOU WILL BE GIVEN THE POTENTIALS
CHAT: BUT NO REFERENCE OR SUPPORTING INFORMATION
    : NO
CHAT: SOURCE :VALUES GIVEN IN A REVIEW ARTICLE
CHAT:       OTHER RELEVANT INFORMATION :
CHAT: SOURCE :THE ERROR IS PROBABLY MUCH SMALLER THAN 10%.-
CHAT:       AUTHOR AND REFERENCE :
CHAT: NEW METHODS FOR CALCULATING LONG-RANGE INTERMOLECULAR FORCES
CHAT: A.DALGARNO  ADV.CHEM.PHYS. 12,143,(1967)
CHAT:   ERROR(RELATIVE) :-     0.100000E 02 %
CHAT:           V = -C6/R**6
CHAT: WITH R INAU   ,C6=  0.1390E 04 GIVES V INAU
CHAT:  2  RKR                    0.379E 01 TO 0.752E 01 (INTERMEDIATE)
CHAT:  3  BORN-MAYER             0.100E 01 TO 0.300E 01 (SHORT)
MCS : BREAK:  8107  ON LINE LIMIT
    : $RESUME
CHAT: 99  OTHER FITS
CHAT: MORE POTENTIALS?
    : NO
CHAT: MORE STATES?
    : YES
CHAT: LIST ?
    : ?
CHAT: DO YOU WANT THE STATES LISTED AGAIN ?
    : YES
CHAT: STATES STORED FOR LI  -  LI
CHAT:   NO.      STATE                              NO. OF POTENTIALS
CHAT:    1     LI2    X 1 SIGMA + (G)                      3
CHAT:    2     LI2    A 1 SIGMA + (U)                      1
CHAT:    3     LI2    B 1 PI (U)                           1
CHAT:    4     LI2    C 1 PI (U)                           1
CHAT:    5     LI+( 1 SINGLET S)LI                         1
CHAT:    6     LI+( 1 SINGLET S)2                          1
CHAT:    7     LI+( 1 SINGLET S)LI+(2 SINGLET S)           1
CHAT:    8     LI+( 1 SINGLET S)LI+(2 TRIPLET S)           1
CHAT:    9     LI+( 2 SINGLET S)LI                         1
MCS : BREAK:  8107  ON LINE LIMIT
    : $RESUME
CHAT:   10     LI+( 2 SINGLET S)2                          1
CHAT:   11     LI+( 2 SINGLET S)LI+(2 TRIPLET S)           1
CHAT:   12     LI+( 2 TRIPLET S)LI                         1
CHAT:   13     LI+( 2 TRIPLET S)2                          1
CHAT:   99      ANY OTHER STATE
CHAT: WHICH ?
    : 9
CHAT: ENERGY AND LENGTH UNITS ?
    : EV A
CHAT: ALL,BEST, OR RNGE ?
    : BEST
```

```
CHAT: TYPE"£RUN,CONT"
    : £RUN,CONT
MCS : CONT(CORE: 8192)

CONT: PLEASE WAIT A SECOND WHILE DATA IS READ FROM A FILE
CONT: THE READING IS COMPLETE .
CONT: TYPE"£RUN,CURV"
    : £RUN,CURV
MCS : E004 /SUB-FILE NOT FOUND
    : £RUN,CHAT
MCS : CHAT(CORE:12928)

CHAT: MORE STATES?
    : NO
CHAT: OTHER ATOMS ?
    : YES
CHAT: ATOM PAIR?
    : H H X
CHAT: ENERGY AND LENGTH UNITS ?
    : AU AU
CHAT: ALL,BEST, OR RNGE ?
    : ALL
CHAT: POTENTIALS STORED FOR   H2   X 1  SIGMA + (G)
CHAT: NO    TYPE                  RANGE(AU  )
CHAT:  1  LONG RANGE EXPANSION  0.580E 01 TO 0.990E 02 (LONG RANGE  )
CHAT:  2  VAN DER WAAL'S COEFF  0.580E 01 TO 0.990E 02 (LONG RANGE  )
CHAT:  3  VAN DER WAAL'S COEFF  0.580E 01 TO 0.990E 02 (LONG RANGE  )
CHAT:  4  VAN DER WAAL'S COEFF  0.580E 01 TO 0.990E 02 (LONG RANGE  )
CHAT:  5  RKR                   0.780E 00 TO 0.621E 01 (INTERMEDIATE)
CHAT:  6  RKR                   0.780E 00 TO 0.616E 01 (INTERMEDIATE)
CHAT: 99  OTHER FITS
CHAT: WHICH?
    : 99
CHAT: MORE STATES?
    : NO
CHAT: OTHER ATOMS ?
    : NO
CHAT: HALTED:-  00
    : £ENDJOB
MCS : LINE   14        LOGOUT/ BUNK    ABBF0112
      TIME: 15/08/21
      DATE: 22/10/71
```

Enquiry 2 to a Book Retrieval Package

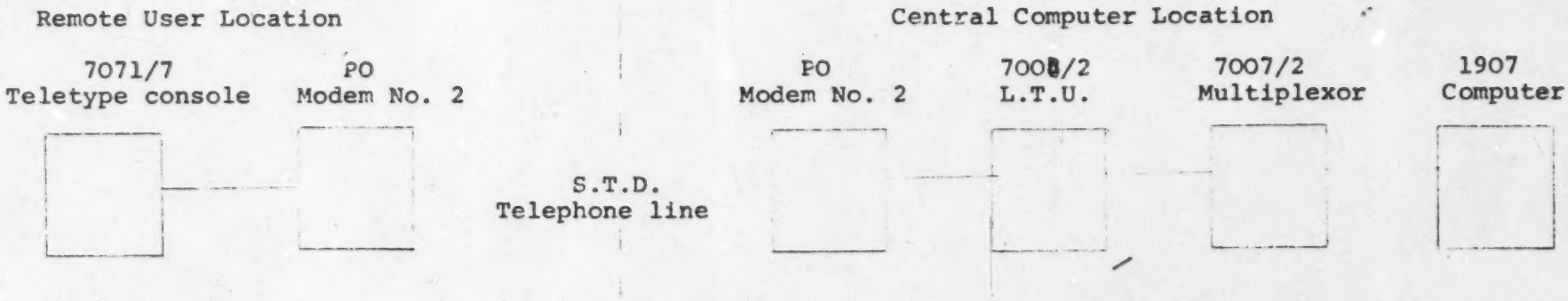
```
MCS : READY      < VERSION  9        FDS ELS
    : $JOB,INFR,AEGD1254
MCS : PASSWORD?
    : ********
MCS : LINE   14        LOGIN / INFR     AEGD1254
      TIME: 14/29/57
      DATE: 22/10/71
    : $RUN,RIOT
MCS : RIOT(CORE: 7808)

RIOT: HALTED:-  LD
    : $GO,20
RIOT: INTERACTIVE SUBJECT INDEX OF ATOMIC AND MOL. PHYSICS RECORDS
RIOT: ARE YOU FAMILIAR WITH THE SYSTEM?
    : YES
RIOT: KEY?
    : HYDROGEN ISOTOPES
RIOT: KEY:    2 DOCS /    2 HDS
RIOT: R,H,T OR M?
    : M
RIOT: KEY?
    : DEUTERIUM
RIOT: NEW KEY:    6 DOCS /    7 HDS
RIOT: INTERSECTION:    1 DOCS /    1 HDS
RIOT: UNION:    7 DOCS /    9 HDS
RIOT: N,I,P OR U?
    : U
RIOT: R,H,T OR M?
    : M
RIOT: KEY?
    : TRITIUM
RIOT: NEW KEY:   12 DOCS /   16 HDS
RIOT: INTERSECTION:    0 DOCS /    0 HDS
RIOT: UNION:   19 DOCS /   25 HDS
RIOT: N,I,P OR U?
    : U
RIOT: R,H,T OR M?
    : M
RIOT: KEY?
    : PLASMA
RIOT: NEW KEY:   25 DOCS /   40 HDS
RIOT: INTERSECTION:    1 DOCS /    4 HDS
RIOT: UNION:   43 DOCS /   63 HDS
RIOT: N,I,P OR U?
    : P
RIOT: R,H,T OR M?
    : M
RIOT: KEY?
    : HYDROGEN
RIOT: NEW KEY:  122 DOCS /  210 HDS
RIOT: INTERSECTION:    5 DOCS /   10 HDS
RIOT: UNION:  136 DOCS /  231 HDS
RIOT: N,I,P OR U?
    : U
```

```
RIOT: R,H,T OR M?
    : M
RIOT: KEY?
    : PLASMA
RIOT: NEW KEY:  35 DOCS /  40 HDS
RIOT: INTERSECTION:   6 DOCS /  16 HDS
RIOT: UNION: 151 DOCS / 258 HDS
RIOT: N,I,P OR U?
    : I
RIOT: R,H,T OR M?
    : H
RIOT: THIS PAPER PRESENTS THE SOLUTIONS OF THE SCHROEDINGER EQUATION FO
      R HYDROGEN WITH THE APPLICATION OF VARIOUS BOUNDARY COND
RIOT: ITIONS
RIOT: THE RESULTS ARE OF SOME SIGNIFICANCE IN THE PRESSURE RANGE OF ST
      ELLAR ATMOSPHERES OR EVEN OF LABORATORY PLASMAS
RIOT: USEFUL?
    : YES
RIOT: RESULTS FOR HYDROGEN PLASMAS ARE PRESENTED AND DISCUSSED
RIOT: USEFUL?
    : YES
RIOT: TITLE:
RIOT: ON THE BEHAVIOUR OF HYDROGEN ISOTOPES IN A D.C. ARC PLASMA
RIOT: THE RADIAL DISTRIBUTION OF D AND H EMISSION IN A D.C
RIOT: ARC PLASMA BURNING IN D/SUB 2/O AND H/SUB 2/O VAPOURS HAS BEEN E
      STIMATED
RIOT: ENRICHMENT OF ATOMIC STATE DEUTERIUM IN THE PLASMA COMPARED TO T
      HE INITIAL MIXTURE HAS BEEN OBSERVED
RIOT: ARC PLASMA
RIOT: USEFUL?
    : YES
RIOT: MOTIVATED BY RECENT EXPERIMENTS DIRECTED TOWARDS PROVIDING NEUTR
      AL ATOMS FOR INJECTION INTO PLASMA DEVICES, THE AUTHORS
RIOT: PRESENT RESULTS FOR THE POPULATION OF HIGHLY EXCITED HYDROGEN AT
      OMS IN THE FINAL OUTGOING BEAM FORMED WHEN AN INCIDENT B
RIOT: EAM OF PROTONS IS PASSED THROUGH A NEUTRALIZING TARGET OF HYDROG
      EN, LITHIUM, OR SODIUM
RIOT: USEFUL?
    : NO
RIOT: TITLE:
RIOT: X RADIATION FROM OPTICAL AND INNER-SHELL TRANSITIONS IN A HIGHLY
       IONIZED DENSE PLASMA
RIOT: X-RAY LINE EMISSION ORIGINATING FROM 'OPTICAL' (DIPOLE AND INTER
      COMBINATION) TRANSITIONS IN HELIUMLIKE COPPER, IRON, AND
RIOT:  TITANIUM AND HYDROGENIC IRON AND TITANIUM IONS HAS BEEN OBSERVE
      D IN A CONCENTRATION DENSE PLASMA FORMED IN A LINEAR LOW
RIOT: -PRESSURE DISCHARGE
RIOT: CONTINUUM EMISSION AT WAVELENGTHS SHORTER THAN THE LYMAN-SERIES
      LIMIT FOR HYDROGENIC SPECIES HAS BEEN USED FOR ELECTRON
RIOT: TEMPERATURE AND DENSITY DETERMINATION AND AS EVIDENCE SUPPORTING
       A THERMAL-ELECTRON COLLISIONAL IONIZATION MODEL
RIOT: PLASMA DYNAMICS STUDIES INDICATE THE EXISTENCE OF AN AXIALLY PRO
      PAGATING RADIAL PINCH, COLLAPSING NEAR THE ANODE TO A MI
RIOT: NUTE POINT
```

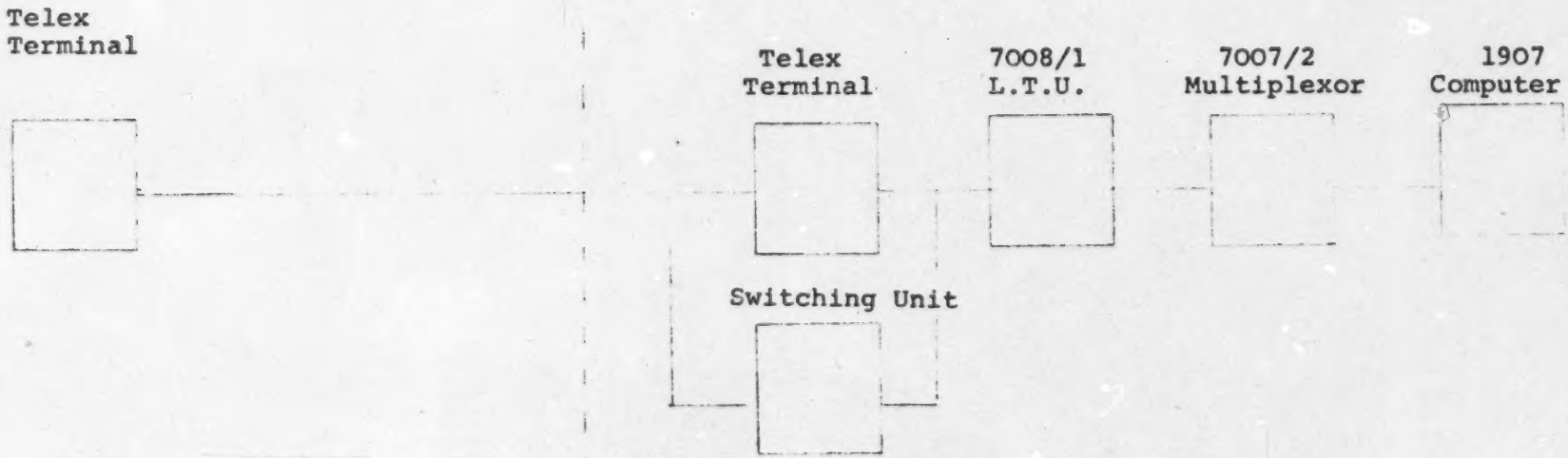
```
RIOT: USEFUL?
    : NO
RIOT: COLLISIONAL IONIZATION RATES FOR C IV, N V, AND O VI AS WELL AS
      FOR O V AND NE VII ARE DEDUCED FROM THE TIME HISTORY OF
RIOT: SPECTRAL LINES EMITTED BY THESE IONS IN A HOT PLASMA
RIOT: THE PLASMA (IN THE ELECTRON TEMPERATURE RANGE 100-260 EV) IS PRO
      DUCED IN A 15-KJ THETA-PINCH DEVICE, AND IT IS ANALYZED
RIOT: USING THE LIGHT-SCATTERING TECHNIQUE
RIOT: THE RESULTS ARE CONSISTENT WITH THEORETICAL CALCULATIONS FOR O V
      I AND WITH A SEMIEMPIRICAL FORMULA BASED ON THEORETICAL
RIOT: CALCULATIONS FOR HYDROGENIC IONS BUT SMALLER BY FACTORS 1.5-2
RIOT: USEFUL?
    : NO
RIOT:  R,T OR M?
    : R
RIOT: "QUANTUM-MECHANICAL CELLULAR METHODS FOR INVESTIGATING THE BEHAV
      IOUR OF MATERIALS UNDER PRESSURE"
RIOT:  BY BARCZA, S.
RIOT: REF.NO.=187899 PUBLISHED IN ASTROPHYS. SPACE SCI. (NETHERLANDS)
        VOL.8, NO.1    JULY 1970
RIOT: "EFFECTS OF NONELASTIC COLLISIONS IN PARTIALLY IONIZED GASES. II
      . NUMERICAL SOLUTION AND RESULTS"
RIOT:  BY SHAW, J.F. MITCHNER, M. KRUGER, C.H.
RIOT: REF.NO.=133849 PUBLISHED IN PHYS. OF FLUIDS (USA)    VOL. 13, NO
      . 2    FEB. 1970
RIOT: "ON THE BEHAVIOUR OF HYDROGEN ISOTOPES IN A D.C. ARC PLASMA"
RIOT:  BY VUKANOVIC, D. VUKANOVIC, V.
RIOT: REF.NO.=133879 PUBLISHED IN SPECTROCHIM. ACTA (GB)    VOL.24B, N
      O.10    OCT. 1969
RIOT:  R,T OR M?
    : X
RIOT: THANK YOU AND GOOD DAY
RIOT: DELETED:- OK
    : $END,JOB
MCS : LINE   14       LOGOUT/ INPR    AECD1254
      TIME: 14/43/49
      DATE: 22/10/71
```

APPENDIX 8

ICL DATA TRANSMISSION SYSTEM
VIA TELEPHONE LINK



ICL DATA TRANSMISSION SYSTEM
VIA PUBLIC TELEX LINK



APPENDIX 9

COSTS OF REMOTE LOCATIONS

		Annual Rental	Connection Charge	Selling Price	Annual Maintenance
Remote Telex Installation	1 x PO Telex Terminal (with hard copy, paper tape reader and paper tape punch)	£295	£10		
	Total	£295	£10		
Remote Teletype Installation	1 x 7071/7 ICL Teletype Console	£324		£650	£60
	1 x PO Modem No. 2) 1 x PO Telephone)	£100			
	Total	£424		£650	£60

Transmission Charge 1p per Telex Unit 1p per Telephone Unit

Connection Charge

See Appendix 11 for P.O. Tariffs

APPENDIX 10

COSTS AT CENTRAL COMPUTER INSTALLATION

		Annual Rental	Connection Charge	Selling Price	Annual Maintenance
Telex System	1 x PO Telex Terminal	£295 *	£10		
	1 x PO Switching Unit	£ 10 *			
	1 x 7008/1 Telegraph Line Termination Unit	£384		£1,450	£36
	Total	£779	£10	£1,450	£36
Teletype System	1 x PO Modem No. 2	£100			
	1 x PO Telephone				
	1 x 7008/2 Telephone L.T.U.	£468		£1,750	£48 *
	Total	£568		£1,750	£48

* The P.O. new Data Control Equipment (DCE3) would replace Telex Terminals and switching units at a proposed annual rental of £240. See Appendix 12.

Post Office Datel Services

APPENDIX 11

Section 1

Equipment rentals and connection charges

Modems

	Annual rental
Modem No 1	£100
Modem No 2	£100
Modem No 7	£200
Modem No 8	provisional £420
Modem No 9 (Table mounted)	provisional £480
Modem No 9 (Rack mounted)	provisional £580

Note: Connection charge nil

Racking for modems

	Annual rental
Modem No 1 Modem No 2 Modem No 7	£35 per rack

DATEL 100 (Private circuit)

		Annual rental
Teleprinter producing printed page copy and punched tape		£170
Teleprinter 'all codes'		£7
Automatic tape transmitter		£65
Reperforator No 2 – fully punched tape		£120
Teleprinter No 15 with reperforating and tape transmitting attachment	50 baud	£250
	75 baud	£300

Note: Connection charge of £10 for each major item of apparatus (this is in addition to appropriate circuit connection charges – see Section 3)

DATEL 100 (Telex)

	Annual rental
Telex installation fitted for automatic transmission and reception of 5-bit coded data (using the International Alphabet No 2) in punched paper tape form	£295
Teleprinter No 15 as above	£300
Error detection unit	£120
Private apparatus connecting unit	£12
Teleprinter 'all codes' modification	£7

Note: The connection charge for a telex exchange line is £15, but for a major item of apparatus provided otherwise than with an exchange line, the connection charge is £10.

Section 2

Call charges

Telex

Inland telex calls are charged in 1p units. The amount of transmission time which can be bought is as follows:

	Time bought for 1p
Between telex centres 35 miles apart	60 seconds
Between telex centres 35–75 miles apart	30 seconds
Between telex centres over 75 miles apart	15 seconds

Telephone

Dialled direct

	Time bought for 1p		
	Peak Rate	Standard Rate	Cheap Rate
	Mon–Fri 9am–12 noon	Mon–Fri 8am–9am 12 noon–6pm	Every night 6pm–8am Sat–Sun All day
Local Calls (From STD exchanges)	6 mins	6 mins	12 mins
Trunk Calls			
Up to 35 miles	20 seconds	30 seconds	72 seconds
35–50 miles	12 seconds	15 seconds	36 seconds
Over 50 miles	8 seconds	10 seconds	36 seconds

Connected by operator

	3 minute call – minimum charge (each subsequent minute or part of minute at ½ rate shown)			
	Peak Rate	Standard Rate	Intermediate Rate*	Cheap Rate*
	Mon–Fri 9am–12 noon	Mon–Fri 8am–9am 12 noon–6 pm	Saturday 8am–6pm	Every night 6pm–3am Sunday All day
Trunk calls up to 35 miles	10½p	9p	6p	3p
35–50 miles	18p	13½p	9p	6p
Over 50 miles	25½p	22½p	15p	9p

*These rates may be suspended on certain days at Christmas and the New Year.

continued overleaf

Section 3

Private circuit charges

Telegraph
Examples of annual rentals for these circuits are as follows:

Radial Mileage	Tariff H	Tariff J	Connection Charge
	£pa	£pa	£pa
5 miles	90	90	15
10 miles	162	162	15
20 miles	322	322	20
50 miles	420	550	25
100 miles	460	610	30
200 miles	510	710	35
300 miles	560	785	35

Note: Reduced rentals are applicable where specific groups of telegraph circuits are provided between two addresses.

Speech/Data
Examples of annual rentals for these circuits are as follows:

Radial Mileage	S1	S2	S3	T	Connection Charge
	£pa	£pa	£pa	£pa	£
5 miles	90	112	180	210	15
10 miles	162	208	276	307	15
20 miles	322	408	471	487	20
50 miles	695	815	860	934	30
100 miles	1145	1265	1315	1480	40
200 miles	1735	1855	1905	2085	50
300 miles	2200	2340	2390	2570	50

Wideband circuits
Quotations for wideband circuits (48 or 240 kHz) are available on request.

Enquiries about Post Office Datel Services should be addressed to your local Telephone Manager (Sales Division). The address is shown in your Telephone Directory.

The charges shown in this leaflet are correct as at 1 February 1971 but they may be altered subsequently at any time by the Post Office.

Post Office

APPENDIX 12

Post Office Telecommunications

DATA CONTROL EQUIPMENTS

The Post Office has developed Data Control Equipments which will enable computers to originate calls and transmit data over the public telephone and telex networks.

AVAILABLE NOW

		Rental charge	Connection charge
DCE1	Automatically originates a call over the public telephone network	£180 p.a.	£25
DCE2	Provides automatic answering on incoming international calls	£50 p.a.	£25

AVAILABLE EARLY 1971

DCE3	Enables incoming calls to a Telex terminal to be answered automatically and switched to customer's own equipment	see note
DCE3 with dialling unit	Provides automatic calling and answering on Telex lines	see note

NOTE

The prospective rentals for these equipments quoted in our advance information leaflet at March 1970 were based on expected development and production costs which had been quoted by our suppliers. In the event these rose sharply and we regret that we have had to revise our earlier estimate of charges for most of these items. The rentals and connection charges for DCE 1 and DCE 2 equipments (now available) are shown above. Firm charges for DCE 3 and DCE 3 with Dialling Unit cannot yet be quoted but *as a budgetary guide to prospective customers* are expected to be *approximately* as follows:–

	Rental charge	Connection charge
DCE 3	£240	£25
DCE 3 with Dialling Unit	£280	£25

Enquiries about new Datel Services and facilities should be addressed to Post Office Telecommunications Headquarters Data Communications Division Marketing Department 1-6 Lutyens House Finsbury Circus

The charges shown in this leaflet are correct as at 1st October 1970 but they may be altered subsequently at any time by the Post Office.